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(71) **Applicant: KOREA BASIC SCIENCE INSTITUTE** [KR/KR]; 52, Eoeun-dong, Yusung-gu, Daejeon 305-333 (KR).

(72) **Inventors: KIM, Dong Lak;** #10-1202, Garam Apt., Dunsan 3-dong, Seo-gu, Daejeon 302-744 (KR). **KU, Myung Hwan;** #609-704, Neovill Apt., Gojan-dong, Danwon-gu, Ansan-si, Gyeonggi-do 425-795 (KR). **CHOI, Yeon Suk;** #903-605, Yeolmaemaeul 9-danji Apt., 52 1, Noeun-dong, Yuseong-gu, Daejeon 305-768 (KR).

(74) **Agent: KIM, Sun-young;** Korea Coal Center, 10th Floor, 80-6, Susong-Dong, Chongro-Ku, Seoul 110-727 (KR).

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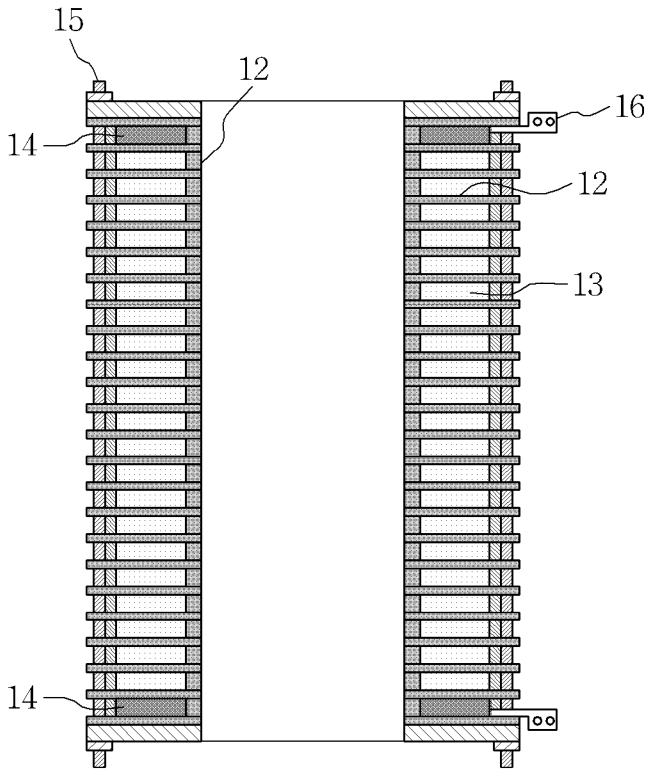
(54) Title: DOUBLE PANCAKE-TYPE SUPERCONDUCTING MAGNET HAVING AUXILIARY COILS



(57) Abstract: A double pancake type superconducting magnet according to the present disclosure is configured by laminating double pancake type coils, and includes: a superconducting wire bobbin that winds and supports a superconducting wire generating magnetic field; a main coil portion that includes the superconducting wire; auxiliary coil portions that are positioned at upper and lower portions of the main coil portion; a supporter that laminates and supports the superconducting wire bobbin; and a current supply bus bar that supplies current to the superconducting magnet.

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Description

Title of Invention: DOUBLE PANCAKE-TYPE SUPER¬ CONDUCTING MAGNET HAVING AUXILIARY COILS

Technical Field

[1] The present disclosure relates to a double pancake type superconducting magnet, and more particularly to a double pancake (DPC) type high-temperature superconducting magnet which may reduce a vertical component of magnetic field using auxiliary coils to remove a decrease of critical current of a coil and a decrease of central magnetic field generated thereby and may maximize efficiency of a device.

Background Art

[2] A magnet requiring high magnetic field such as a nuclear magnetic resonance (NMR) system and a magnetic resonance imaging(MRI) system is made using a superconducting wire material having high driving current. A superconducting phenomenon is a phenomenon in which a substance suddenly loses electrical resistance at a critical temperature and allows 0 resistance current flow. There is a characteristic playing a role of a conductor which loses electrical resistance when it is cooled below a critical temperature and allows 0 resistance current to flow, and such a substance to be called a superconductor. Generally, the superconducting magnet is manufactured by winding a superconducting wire and integrate numbers of coil. The superconducting magnet using a low temperature superconducting magnet and a high temperature superconducting magnet together mainly includes an inside coil 11 and an outside coil 10, as shown in Fig. 1. In addition, the inside coil 11 includes a high temperature main coil 11a and high temperature auxiliary coils 1lb provided at the upper and lower portions. The outside coil 10 is made using a low temperature superconductor (LTS) such as niobium-titanium (NbTi) and niobium-tin (Nb_3Sn) having superconducting characteristics in the vicinity of a liquid helium temperature (-268°C at 1 atm), and the inside coil 11 is made using a high temperature conductor (HTS) having superconducting characteristics in the vicinity of liquid nitrogen temperature.

[3] Recently, according to improvement and growth of critical current of the high temperature superconducting wire material constituting the inside coil 11, the use of the high temperature superconducting wire material is activated in the device generating high magnetic field. However, in this case, there is a problem that the critical current of the superconducting device is decreased according to the direction of the magnetic field line in the high temperature superconducting device. Particularly, in the superconducting magnet in which high magnetic field is generated, there is a problem that magnetic field generated and distributed in the vicinity of the upper and lower portion

of the superconducting coil restricts the critical current of the superconducting coil to decrease efficiency of the device.

Disclosure of Invention

Technical Problem

[4] The present disclosure is directed to providing a double pancake (DPC) type high-temperature superconducting magnet which may reduce a vertical component (vertical magnetic field) of magnetic field using auxiliary coils to remove a decrease of critical current of a superconducting coil and a decrease of central magnetic field generated thereby and may maximize efficiency of an superconducting device.

Solution to Problem

[5] In one aspect, there is provided a double pancake type superconducting magnet configured by laminating double pancake type coils, including: a superconducting wire bobbin that winds and supports a superconducting wire generating magnetic field; a main coil portion that includes the superconducting wire; auxiliary coil portions that are positioned at upper and lower portions of the main coil portion; a supporter that laminates and supports the superconducting wire bobbin; and a current supply bus bar that supplies current to the superconducting magnet.

[6] The superconducting wire may have a tape shape, and the start portion and the end portion of the superconducting wire may be wound on the superconducting wire bobbin to be disposed on the outside of the main coil portion and the auxiliary coil portion.

[7] The auxiliary coil portion may decrease vertical magnetic field generated at the upper and lower portions of the main coil portion, and may raise critical current of the superconducting magnet, to improve efficiency of a device.

[8] The auxiliary coil portion may wind the superconducting wire manifoldly, and may supply current, to decrease vertical magnetic field.

[9] The current supply bus bar may be provided on the outside of the main coil portion and the auxiliary coil portion, may supply current, and may prevent the current supply from being restricted by an influence of the magnetic field.

Advantageous Effects of Invention

[10] According to present disclosure, the auxiliary coil portions are provided at the upper and lower portion of the main coil portion, the vertical magnetic filed generated at the upper and lower portions of the main coil portion is decreased, the decrease of the critical current of the superconducting coil and the decrease of the central magnetic field generated thereby are removed, and thus it is possible to maximize the efficiency of the superconducting device.

Brief Description of Drawings

[11] The above and other aspects, features and advantages of the disclosed exemplary embodiments will be more apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[12] Fig. 1 is a schematic diagram illustrating a high magnetic field generation superconducting magnet of the related art;

[13] Fig. 2 is a schematic diagram illustrating a double pancake type superconducting magnet having auxiliary coils according to the present disclosure;

[14] Fig. 3 is a schematic plan view illustrating a double pancake type superconducting wire coil of a main coil portion according to the present disclosure; and

[15] Fig. 4 is a schematic diagram illustrating a double pancake type superconducting wire coil of an auxiliary coli portion according to the present disclosure.

Mode for the Invention

[16] Hereinafter, a structure of a double pancake type superconducting magnet according to the present disclosure will be described in detail with reference to the drawings.

[17] Fig. 2 is a schematic diagram illustrating a double pancake type having auxiliary coils according to the present disclosure. Referring to Fig. 2, the double pancake type superconducting magnet according to the present disclosure includes a wire bobbin 12, a main coil portion 13, auxiliary coil portions 14, a supporter 15, and a current supply bus bar 16.

[18] A superconducting wire 23 generating magnetic field is wound and supported on the superconducting wire bobbin 12. The superconducting wire bobbin 12 has a type in which the superconducting wire 23 is wound around the main coil portion 13, as a type of surrounding the outside of the main coil portion 13.

[19] The main coil portion 13 includes the superconducting wire 23, and is sequentially laminated using the supporter 15. In this case, an insulating material is interposed between coils of the main coil portion 13 for electrical insulating, and thus it is possible to achieve insulation between layers even in large current. The laminated main coil 13 is fixed by the supporter 15, and it is possible to form a structurally stable structure using a reinforcement material at the upper and lower portions as necessary.

[20] The auxiliary coil portions 14 are positioned at the upper and lower portions of the main coil portion 13. The auxiliary coil portions 14 may reduce a decrease of current of the superconducting wire 23 generated by the magnetic field component (the vertical magnetic field) vertically input to the superconducting magnet by the magnetic field generated when using the wire having the tape shape in the superconducting magnet and a decrease of the central magnetic field thereby.

[21] By reducing eddy current generated by induction to the superconducting wire 23 by the vertical magnetic field using the auxiliary coil portion 14, it is possible to improve

magnetic field stability of the superconducting magnet generating the high magnetic field.

[22] The supporter 15 laminates and supports the main coil portion 13, the auxiliary coil portion 14, and the superconducting wire bobbin 12. In addition, the superconducting magnet may receive the current supplied through the current supply bus bar 16.

[23] The superconducting wire 23 may have a tape shape, and may be wound on the superconducting wire bobbin 12 such that the start portion 19 and the end portion 20 of the superconducting wire are present on the outside of the main coil portion 13 and the auxiliary coil portions 14 as shown in Fig. 3. The superconducting wire is wound around the first main coil 17 from the superconducting wire start portion 19, is wound around the second main coil 18, and is completed to the superconducting wire end portion 20.

[24] The start portion 19 and the end portion 20 of the superconducting wire are disposed on the outside, and thus the current supply bus bar 16 may be provided on the outside of the main coil portion 13 and the auxiliary coil portion 14 as shown in Fig. 2. The current supply bus bar 16 is provided on the outside of the coil portions 13 and 14, and thus it is possible to prevent the current supply from being restricted by the influence of the magnetic field. That is, by the position of the current supply bus bar 16 configured as described above, it is possible to optimize the current lead such that the electrical connection current amount is prevented from being decreased and it is possible to efficiently generate the high magnetic field in the superconducting magnet.

[25] The auxiliary coil portions 14 have the same structure as that of the main coil portion 13, but the conductive wire 23 with various sizes may be wound on the auxiliary coil portion 14. As shown in Fig. 4, the superconducting wire 23 may be wound by two or more layers. When the tape-shaped superconducting wire 23 is manifoldly wound, it is possible to supply a relatively large amount of current, and it is possible to have high current capacity. Accordingly, it is possible to drastically decrease the vertical magnetic field generated at the upper and lower portion of the main coil portion 13.

[26] By such a double pancake type superconducting magnet, the vertical magnetic filed generated at the upper and lower portions of the main coil portion 13 is decreased, the decrease of the critical current of the superconducting coil and the decrease of the central magnetic field generated thereby are removed, and thus it is possible to maximize the efficiency of the superconducting device.

[27] Because the diameter of the auxiliary coil is same with the main coil, the additional space to direction of the diameter of the magnet is not required and there is no loss of space.

[28] And, vertical magnetic field (space) is reduced by auxiliary coil and shielding currents is reduced and the stability of the magnetic field is improved.

[29] The present disclosure has been described above with referent to the examples, but it can be understood that a person skilled in the art can variously amend and modify the present disclosure within the scope which does not deviate from the sprit and concept of the present disclosure described in claims below.

Industrial Applicability

[30] Because the diameter of the auxiliary coil is same with the main coil, the additional space to direction of the diameter of the magnet is not required and there is no loss of space. And, vertical magnetic field (space) is reduced by auxiliary coil and shielding currents is reduced and the stability of the magnetic field is improved.

Claims

[Claim 1] A double pancake type superconducting magnet configured by laminating double pancake type coils, comprising:
a superconducting wire bobbin that winds and supports a superconducting wire generating magnetic field;
a main coil portion that includes the superconducting wire;
auxiliary coil portions that are positioned at upper and lower portions of the main coil portion;
a supporter that laminates and supports the superconducting wire bobbin; and
a current supply bus bar that supplies current to the superconducting magnet.

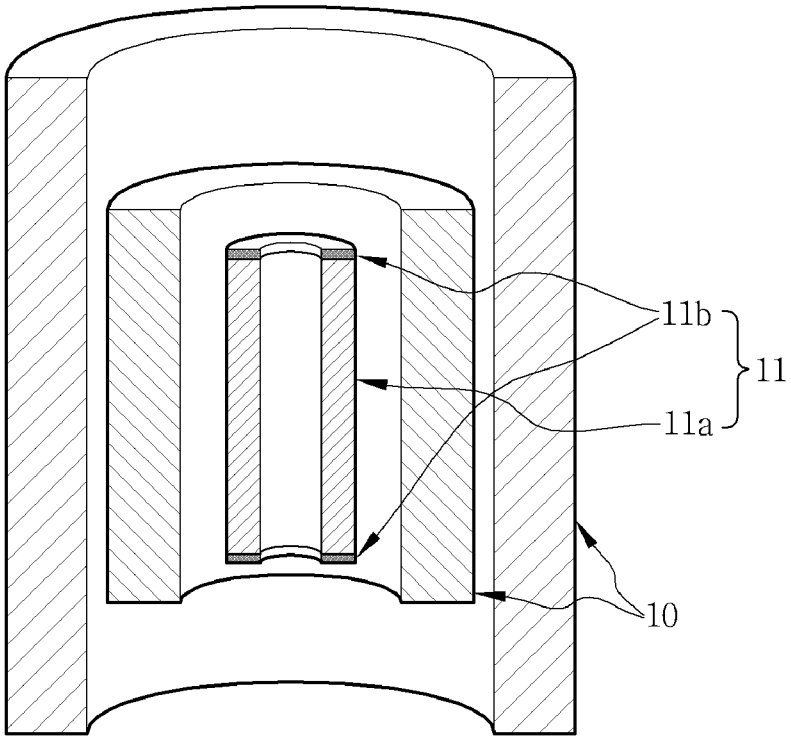
[Claim 2] The double pancake type superconducting magnet according to claim 1, wherein the superconducting wire has a tape shape, and the start portion and the end portion of the superconducting wire is wound on the superconducting wire bobbin to be disposed on the outside of the main coil portion and the auxiliary coil portion.

[Claim 3] The double pancake type superconducting magnet according to claim 1, wherein the auxiliary coil portion decreases vertical magnetic field generated at the upper and lower portions of the main coil portion, and raises critical current of the superconducting magnet, to improve efficiency of a device.

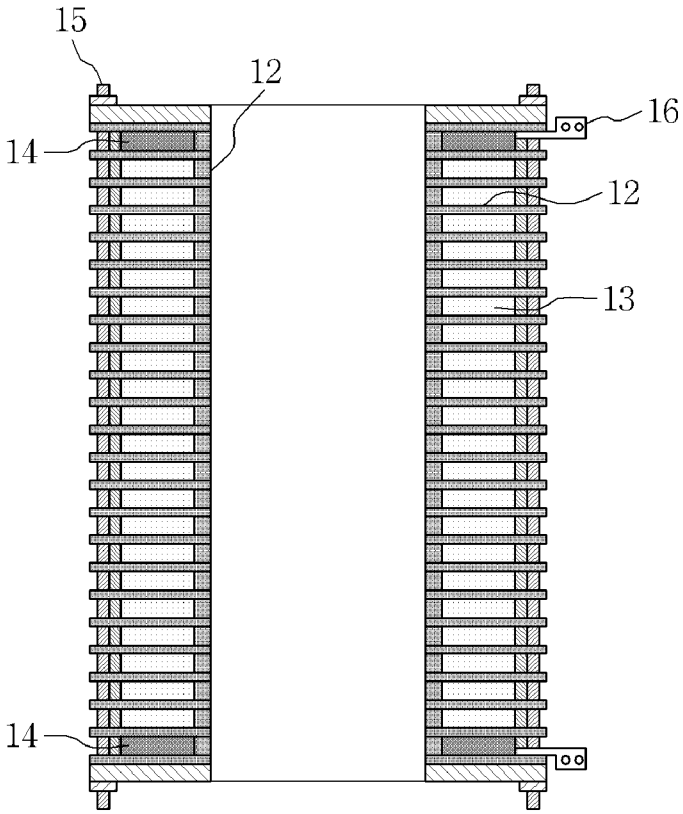
[Claim 4] The double pancake type superconducting magnet according to claim 1, wherein the auxiliary coil portion winds the superconducting wire manifoldly, and supplies current, to decrease vertical magnetic field.

[Claim 5] The double pancake type superconducting magnet according to claim 1, wherein the current supply bus bar is provided on the outside of the main coil portion and the auxiliary coil portion, supplies current, and prevents the current supply from being restricted by an influence of the magnetic field.

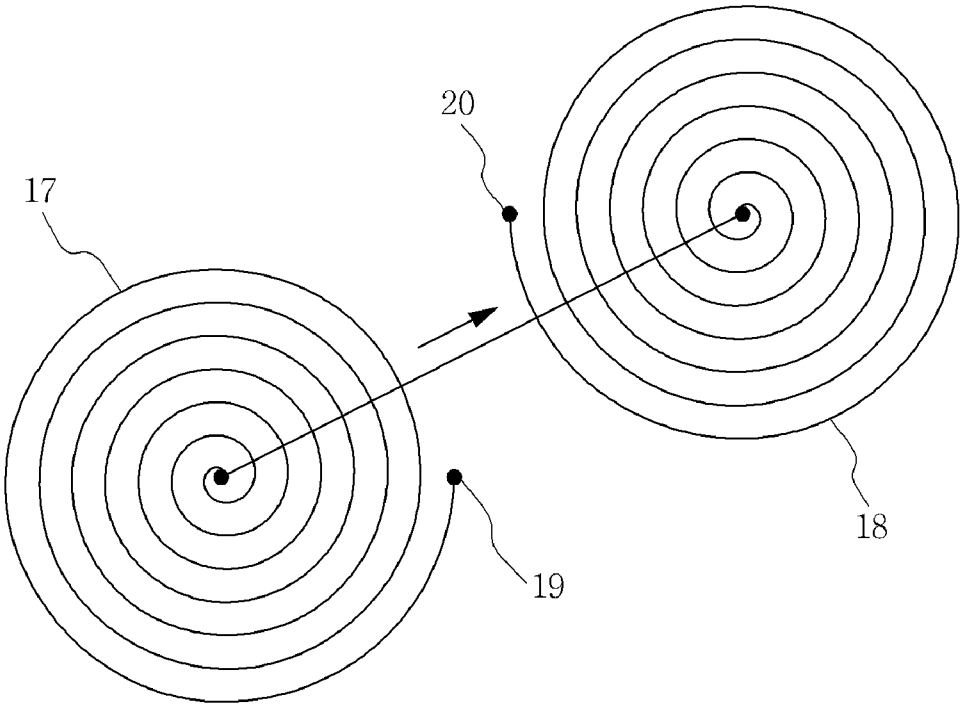
[Fig. 1]



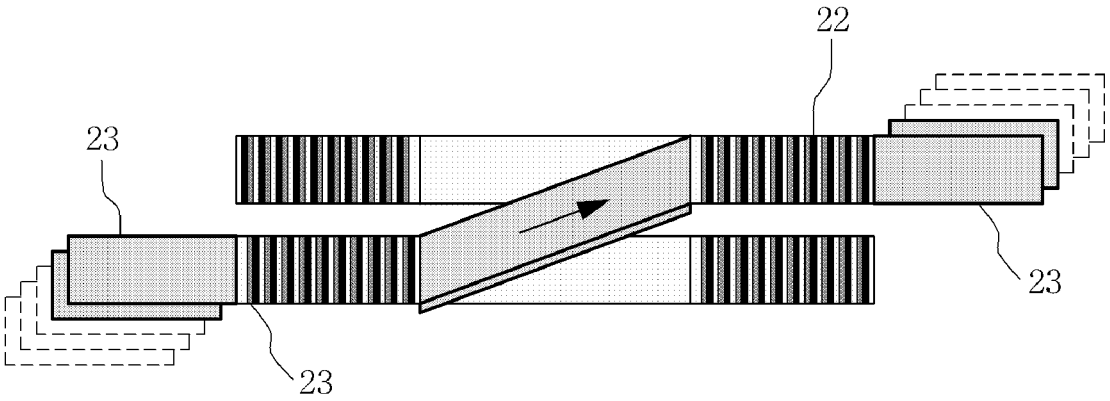
[Fig. 2]



[Fig. 3]



[Fig. 4]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2012/009091

A. CLASSIFICATION OF SUBJECT MATTER

H01F 6/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01F 6/00; G01R 33/3815; H01F 6/06; G01K 7/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: superconducting wire, main coil, auxiliary coil, current supply bus bar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2009-111262 A (SUMITOMO ELECTRIC IND. LTD.) 21 May 2009 See the abstract and figures 1-4.	1-5
Y	JP 08-505493 A (GENERAL ELECTRIC COMPANY) 11 June 1996 See the abstract and figure 1.	1-5
Y	JP 2005-109144 A (HITACHI LTD.) 21 April 2005 See figure 1 and claim 1.	2
Y	JP 08-222426 A (HITACHI LTD.) 30 August 1996 See the abstract and figure 1.	5

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search	Date of mailing of the international search report
07 MARCH 2013 (07.03.2013)	**08 MARCH 2013 (08.03.2013)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

JUNG, Sug Woo

Telephone No. 82-42-481-8443

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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JP 08-505493 A	11.06.1996	JP 03-153243 B2	26.01.2001
		WO 95-12968 A3	18.05.1995
JP 2005-109144 A	21.04.2005	None	
JP 08-222426 A	30.08.1996	None	